Impact of Alternative Rate Structures on Distributed Solar Customer Electricity Bills

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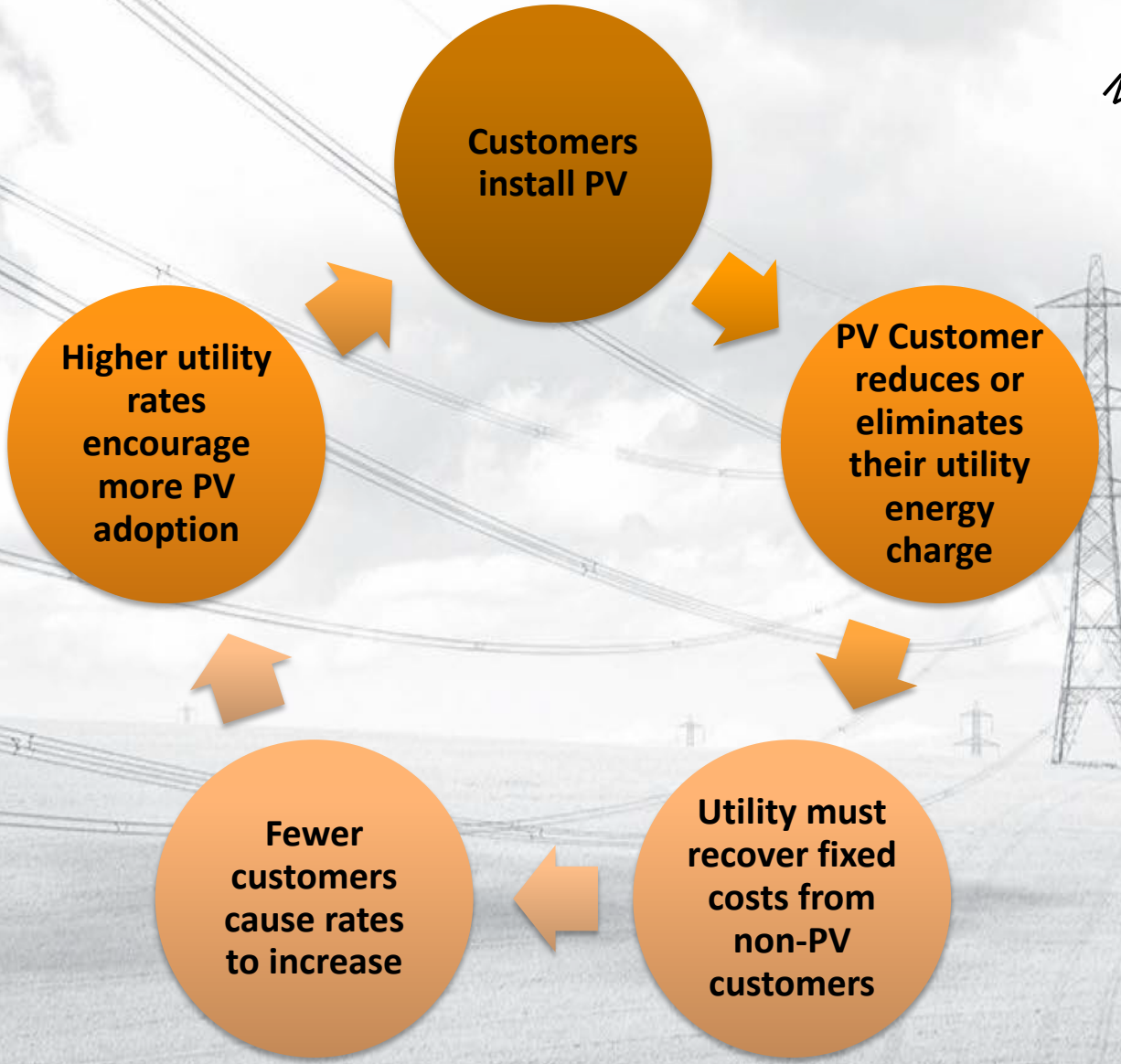
Standard Residential Electricity Customer Billing

- Residential customer bill is typically comprised of:
  - Energy Charge ($/kWh)
  - Fixed charge
  - Adders/Taxes
- Energy charge = largest portion & is dependent on kWh usage
- Most utility costs are fixed
  - infrastructure construction
  - maintenance
  - staff/billing/admin
- Few of utility costs are variable
  - fuel
- Residential customer billing methods do not align with actual utility costs

Impacts of Distributed Solar on Utility Revenue Recovery

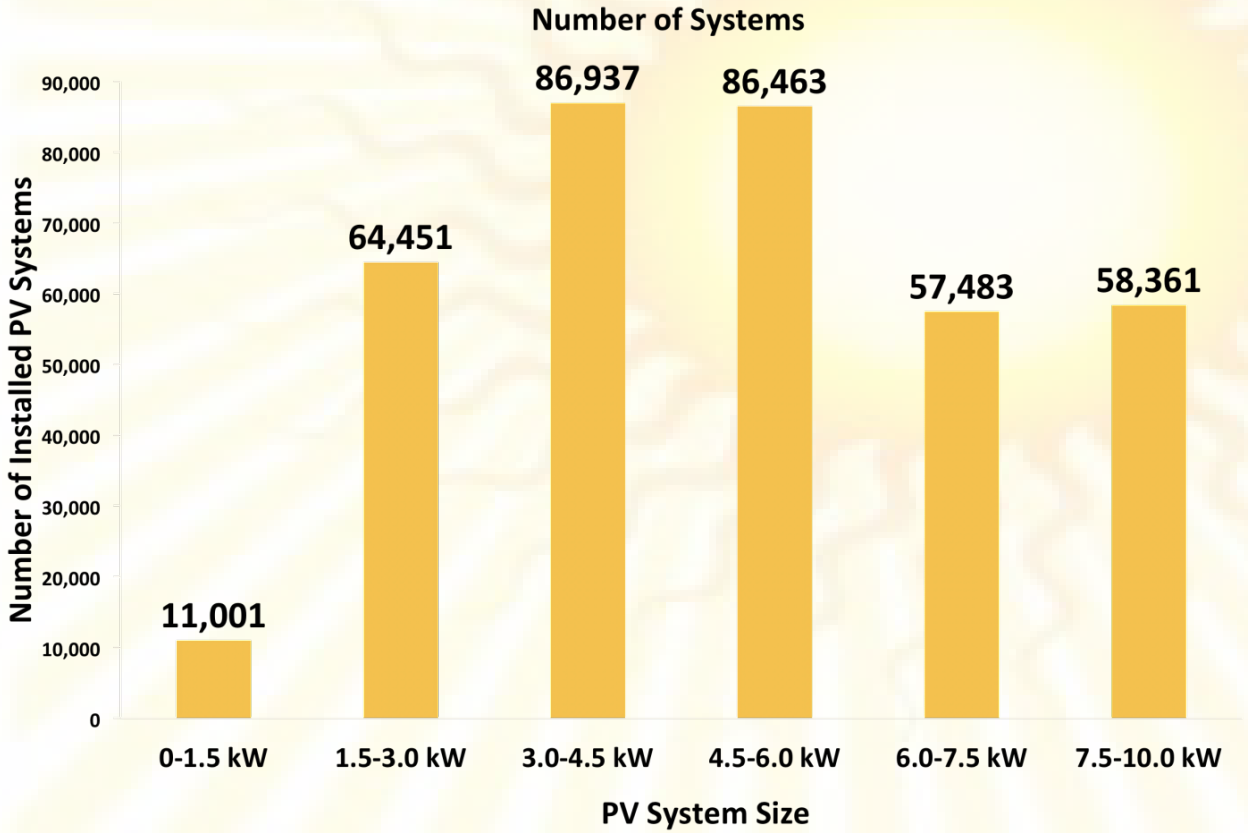


Residential PV Systems in U.S.

>1,800 MW of residential PV

Majority of systems = 3 - 6 kW

Average system size = 5.5 kW



OpenPV; March,2015; 420,335 systems.

State	Utility Average	State Average
AZ	6.02	6.01
CA	4.87	4.53
CO	5.61	4.41
FL	5.29	5.59
MA	5.88	6.03
MN	5.88	6.18
NV	5.78	5.38
NJ	8.78	7.69
NC	3.94	5.34
OR	4.26	4.53
TX	3.92	6.26
AVG.	**5.48**	**5.63**

EIA Form 861 (2015)

To what degree does PV off-set a customer's load?

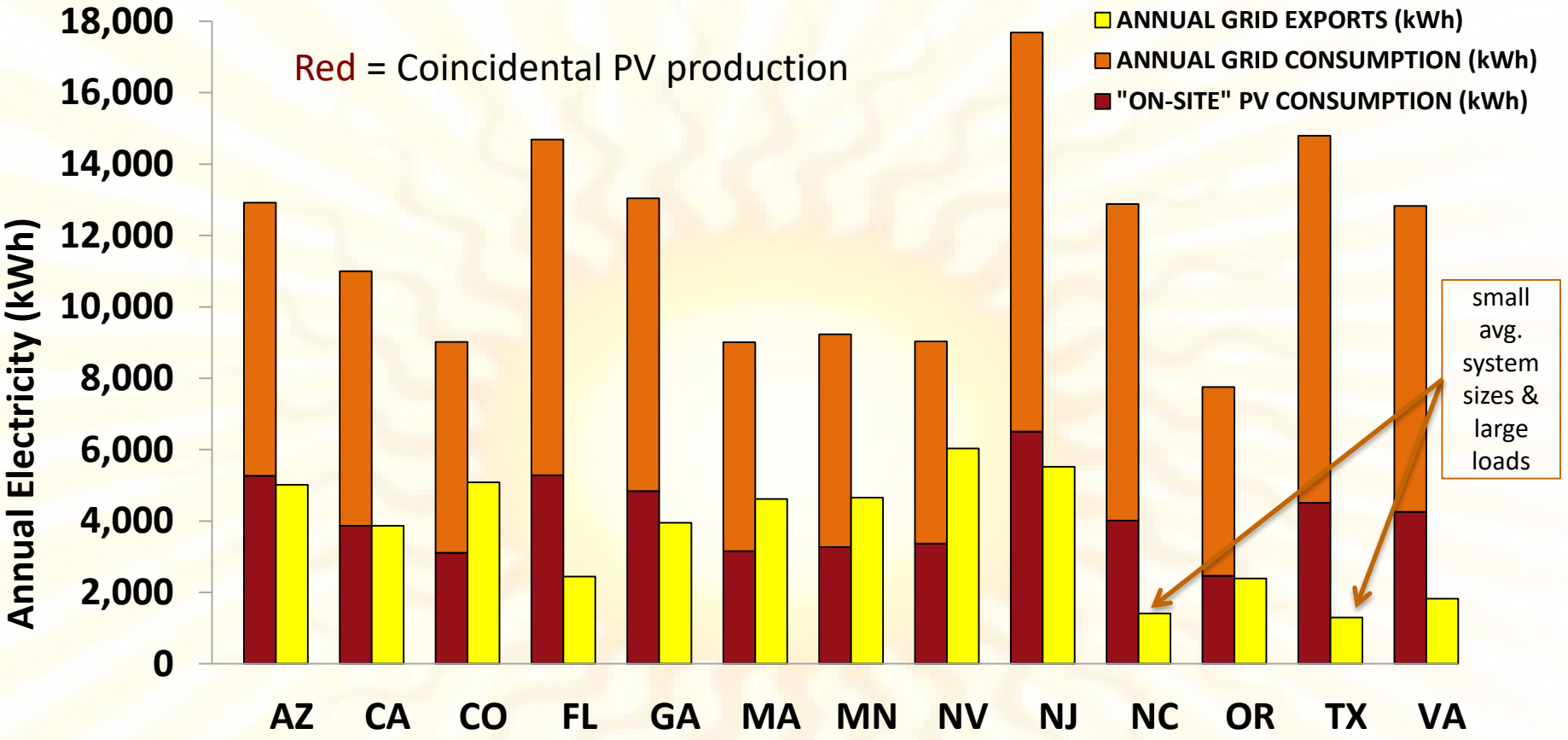
On average, PV generation typically off-sets about 60-90% of a residential customer's annual electricity usage.

State	Percentage offset
Arizona	85% (n=256)
California	89% (n=1,752)
Colorado	95% (n=159)
Florida	85% (n=31)
Massachusetts	86% (n=810)
New Jersey	88% (n=328)
North Carolina	61% (n=222)
Oregon	71% (n=37)
Texas	59% (n=169)

Why does it matter?

Fewer kWh purchased = less utility revenues

How much does PV generation coincide with customer load?

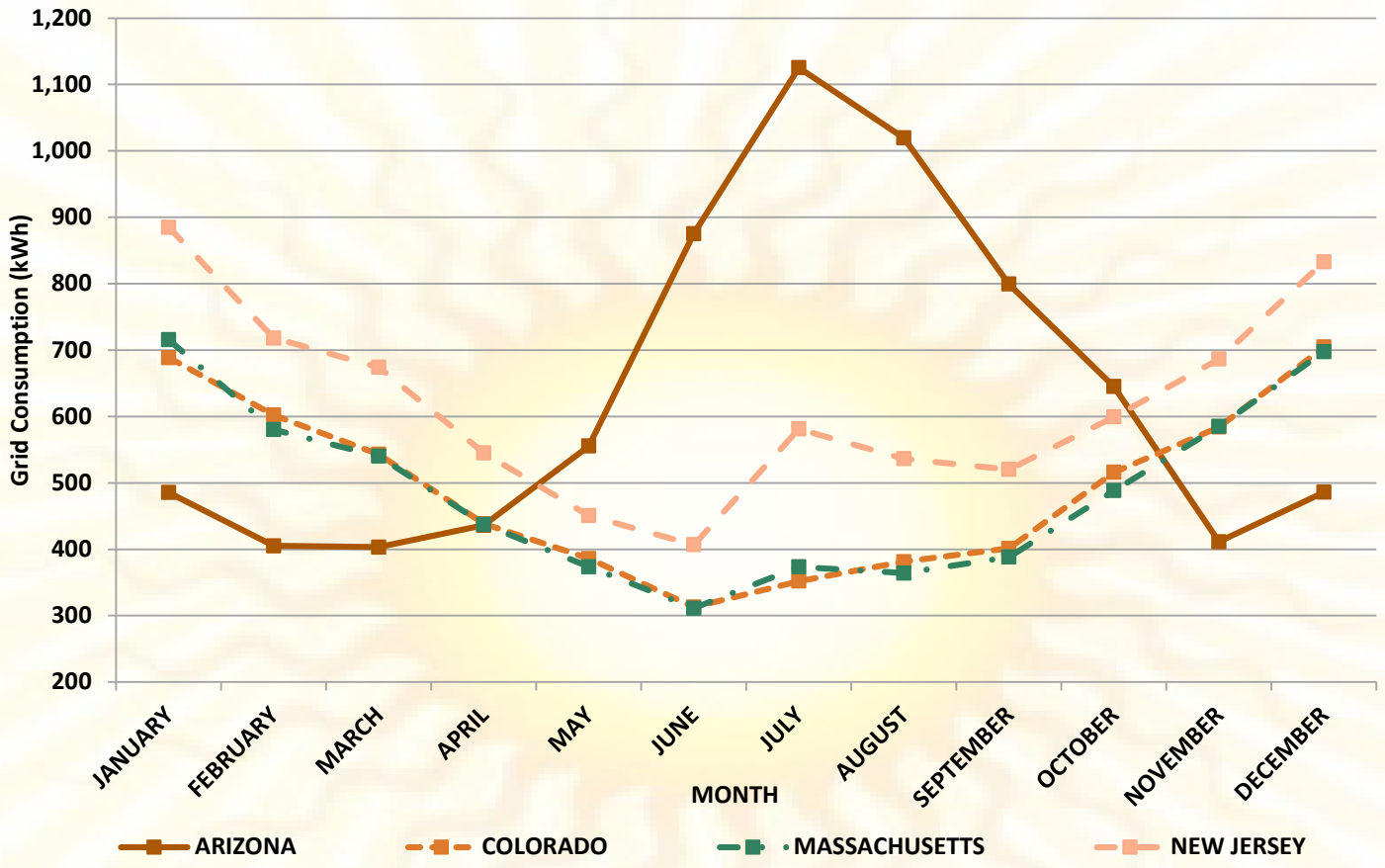


Why does it matter?

Excess PV generation is exported to the utility grid.
The utility must balance the system and provide infrastructure upgrades and maintenance.

PV customers require utility-generated electricity when their PV systems are not generating.
The utility must have capacity available to meet their demand and provide infrastructure to deliver it.

Customer purchases of grid-power vary by time of year



Most grid power is consumed in the winter,
except in states with heavy air conditioning loads (e.g. AZ).

In summer, when PV generation is highest,
customers still consume 300+ kWh/month from the grid.

PV exports to grid vary by time of year

In most locations, PV exports are highest in spring and summer months when generation is high and lighting and electric heating loads are low (except in locations with high air conditioning loads)

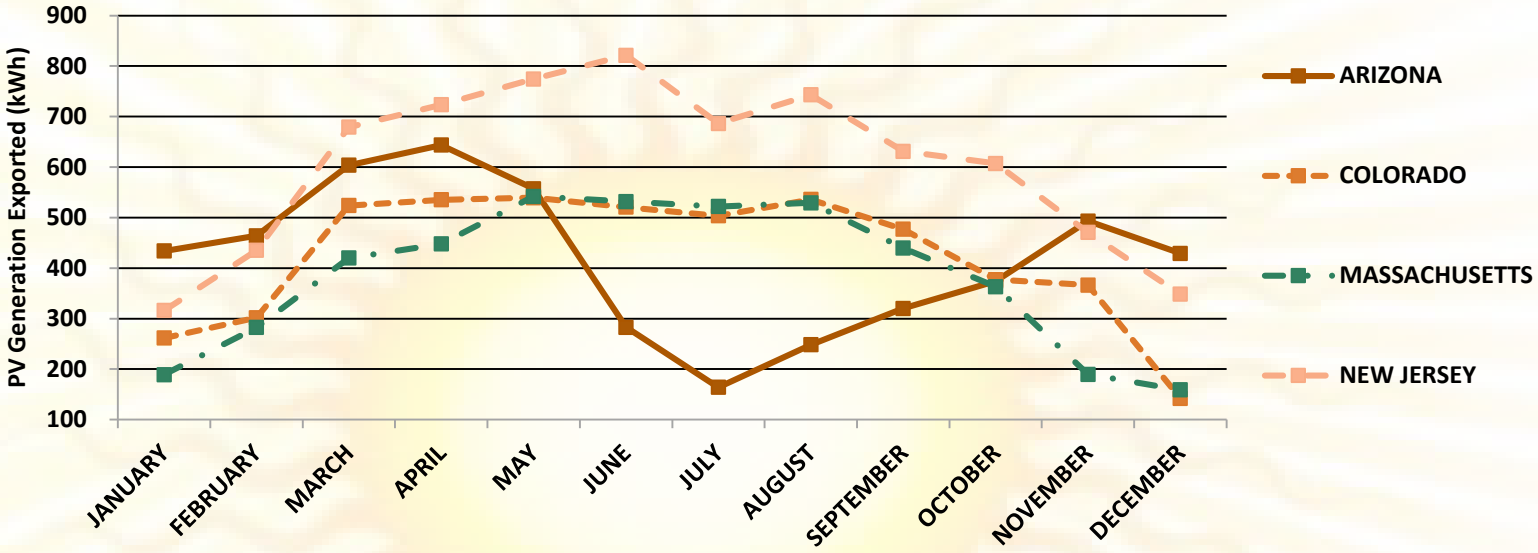
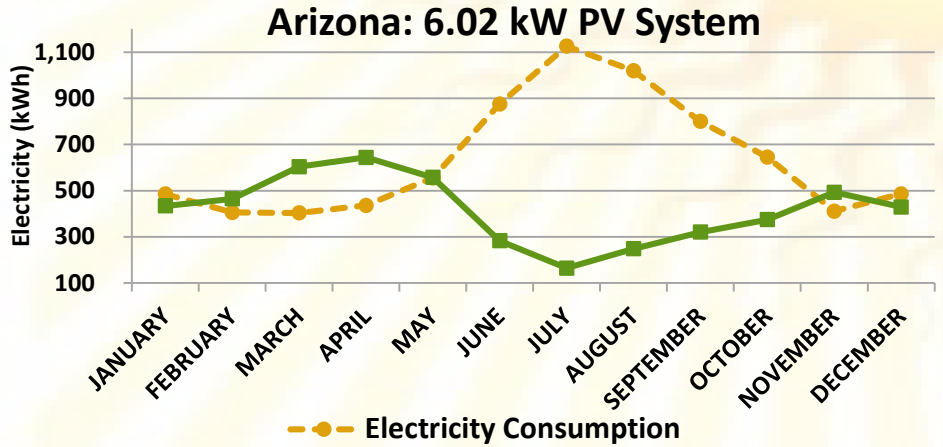


Figure 5: Monthly PV Customer Exports to the Grid, 4 States



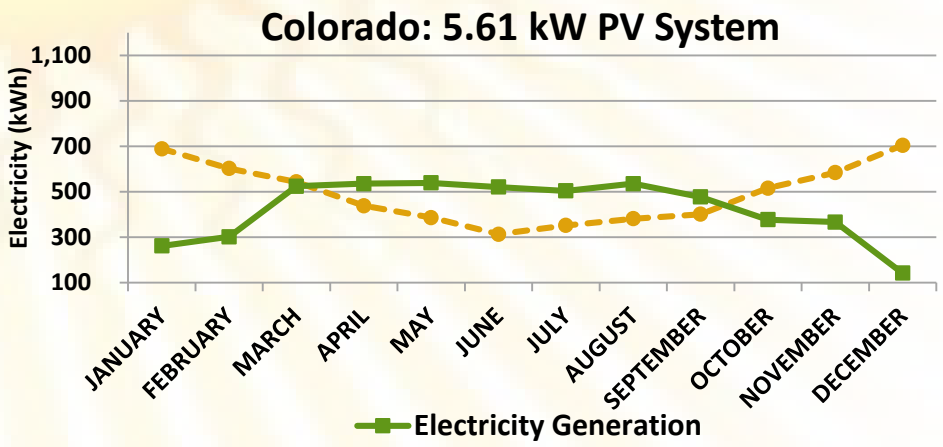


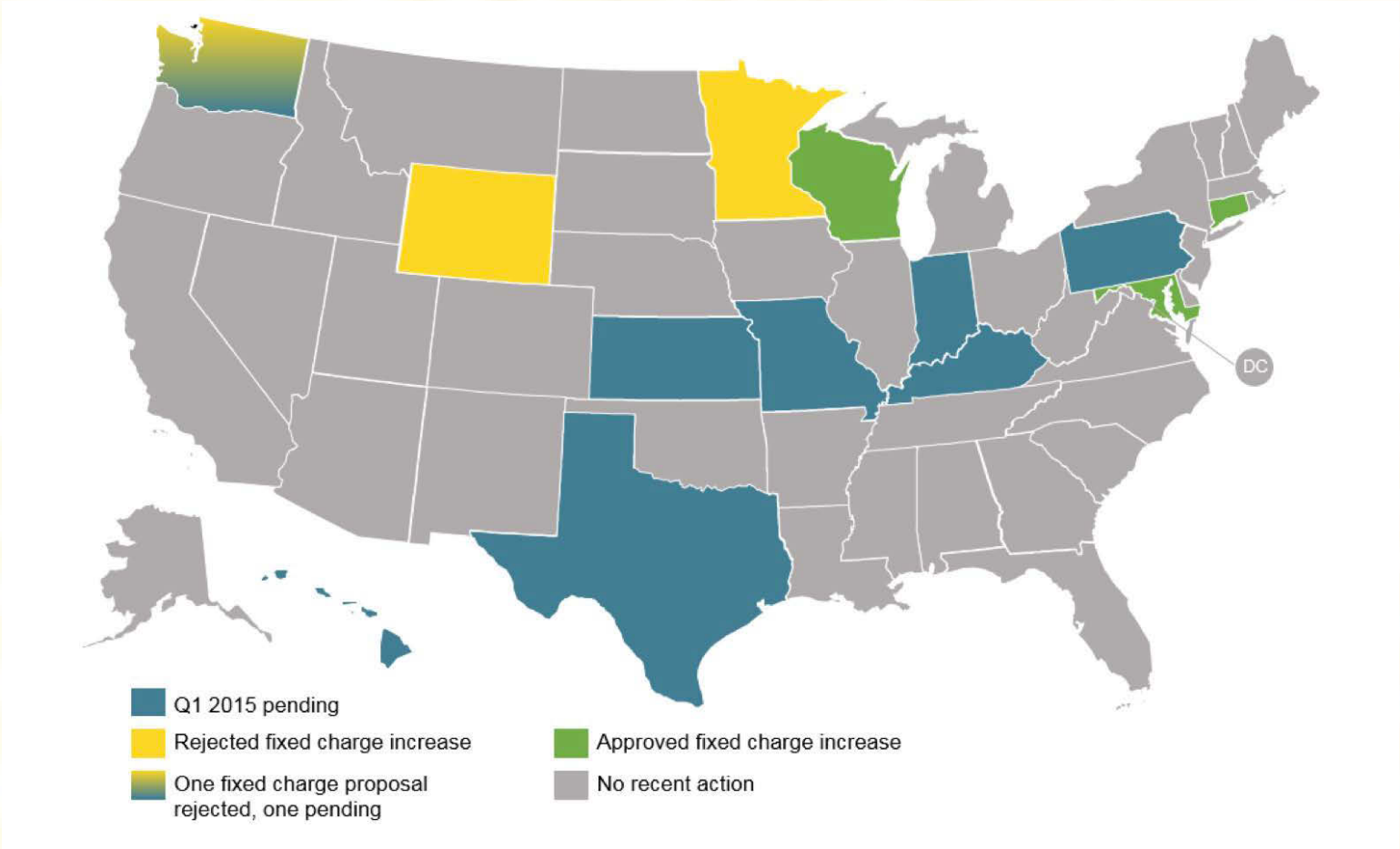
Figure 6: Grid Consumption and Grid Exports for Average PV System Sizes in Arizona and Colorado

Summary of why it matters

- Standard residential rates have high energy charges and low fixed charges
- Utility costs are mostly fixed
- PV customers off-set much of their annual load
- PV customers use the grid as a battery
- Under standard billing and net-metering, PV customers do not pay for the cost of utility infrastructure services
- Cross-subsidization with non-PV customers
- Increased rates induce more customers to install PV

Alternative Rate Design Activity

Increased Fixed Charge Proposals/Approvals Q1 2015

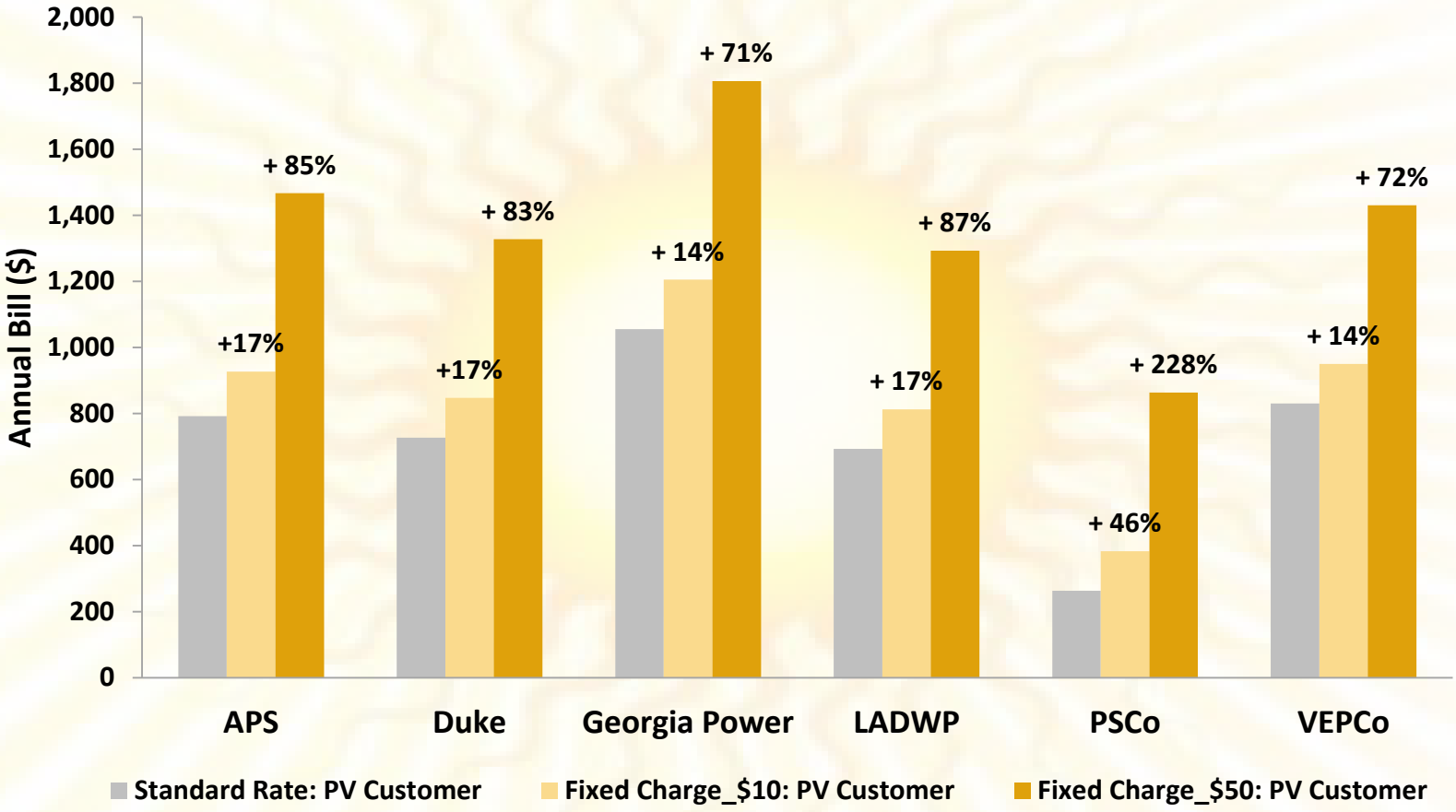


50 States of Solar
NC Clean Energy Technology Center
http://nccleantech.ncsu.edu

Alternative Rate Designs

Standard Rate	• Default customer rate. • Volumetric kWh energy charge + fixed charge + adders.
Increased Fixed Charge	• Increasing the fixed charge component of the bill • Commonly proposed option
Minimum Bill	• Sets the lower limit that a customer will pay each billing period
Demand-Based Rate	• Demand charge component of the bill is based on the maximum kW used over a specified time interval • Typically has a lower energy charge

Impacts of Increasing Fixed Charges on Residential PV Customer Annual Utility Payments



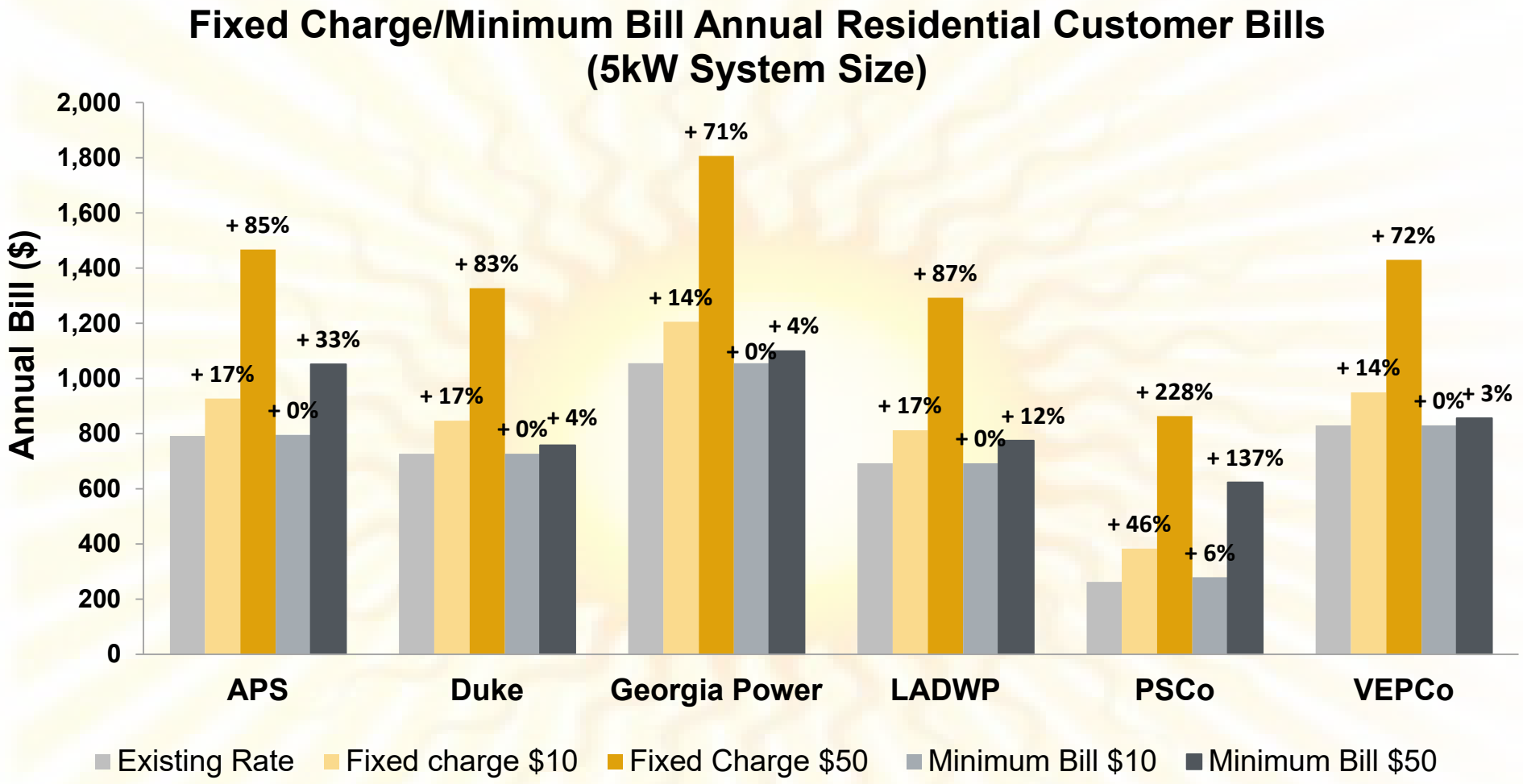
Fixed charges increase bills for everyone, independent of PV system size and % off-set

Based on generation from a 5 KW PV system as simulated in SAM. Standard rate is existing, default rate listed in spring 2015 utility rate sheet.

Increased Fixed Charges: Considerations

- Applied to all customers, or only PV?
- Negatively impact low-income customers
- Discourage energy efficiency
- Effects compounded as they make up larger proportion of the bill
- Easy-to-implement, blanket solution
- Does not consider PV system size or % off-set

Minimum Bills vs. Increased Fixed Charges



Minimum bills impact PV customers in locations where loads are off-set by PV generation for the most months of the year

Based on generation from a 5 KW PV system as simulated in SAM.
Standard rate is the existing, default rate listed in the spring 2015 utility rate sheet.

Impact of Minimum Bills vs. Standard Rate

PUBLIC SERVICE COMPANY OF COLORADO			Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
5kW System	Standard Rate	Monthly Bill WITHOUT PV	$ 101	$ 91	$ 90	$ 80	$ 76	$ 71	$ 79	$ 81	$ 81	$ 82	$ 88	$100
		Monthly Bill WITH PV	$ 56	$ 43	$ 18	$ 8	$ 8	$ 8	$ 8	$ 8	$ 8	$ 8	$ 25	$ 68
	Minimum Bill $50	Monthly Bill WITH PV	$ 56	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 68
		PV Customer Bill Increase from Standard Rate	$ -	$ 7	$ 32	$ 42	$ 42	$ 42	$ 42	$ 42	$ 42	$ 42	$ 25	$ -

VIRGINIA ELECTRIC & POWER COMPANY			Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
5kW System	Standard Rate	Monthly Bill WITHOUT PV	$ 149	$132	$131	$121	$117	$136	$182	$163	$137	$121	$ 126	$138
		Monthly Bill WITH PV	$ 101	$ 80	$ 61	$ 44	$ 31	$ 49	$ 90	$ 79	$ 62	$ 59	$ 78	$ 96
	Minimum Bill $50	Monthly Bill WITH PV	$ 101	$ 80	$ 61	$ 50	$ 50	$ 50	$ 90	$ 79	$ 62	$ 59	$ 78	$ 96
		PV Customer Bill Increase from Standard Rate	$ -	$ -	$ -	$ 6	$ 19	$ 1	$ -	$ -	$ -	$ -	$ -	$ -
	Red highlighting indicates when the minimum bill is triggered in a particular month.													

The minimum bill is triggered 10 months in Colorado; 3 months in Virginia.

A minimum bill of $50 increases PV customer costs in both locations, compared to the standard rate.

Minimum Bills: Considerations

- Can apply to all customers equally
- Triggered only when energy charge is low
- Easy to understand
- Do not discourage efficiency to same degree as fixed charge
- May encourage some PV system down-sizing in regions where most of customer load is off-set (in order to avoid triggering the minimum bill)

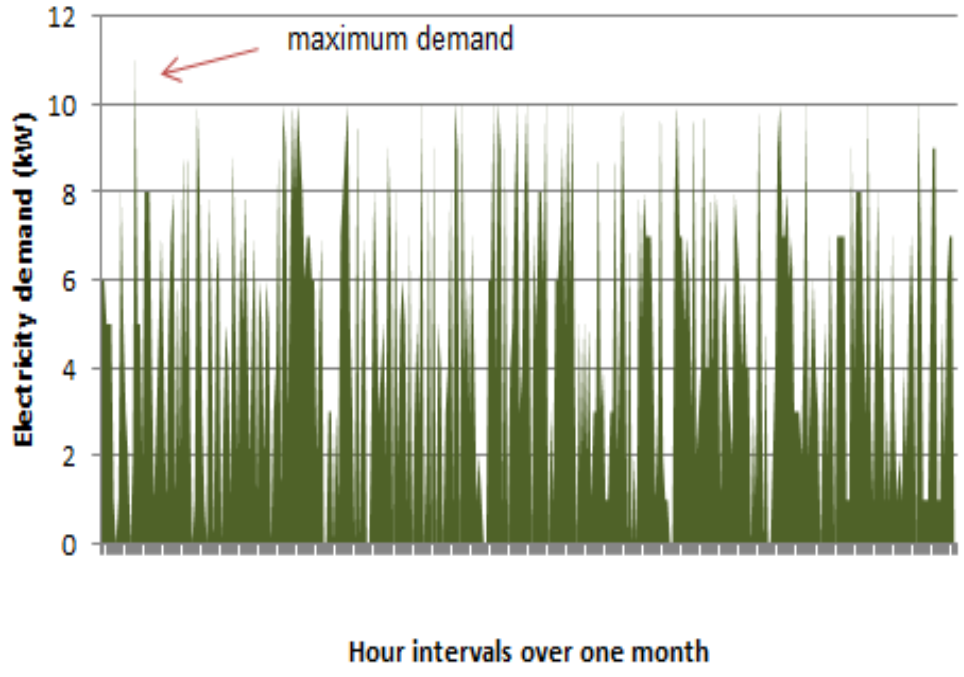
Demand-based rates: How do they work?

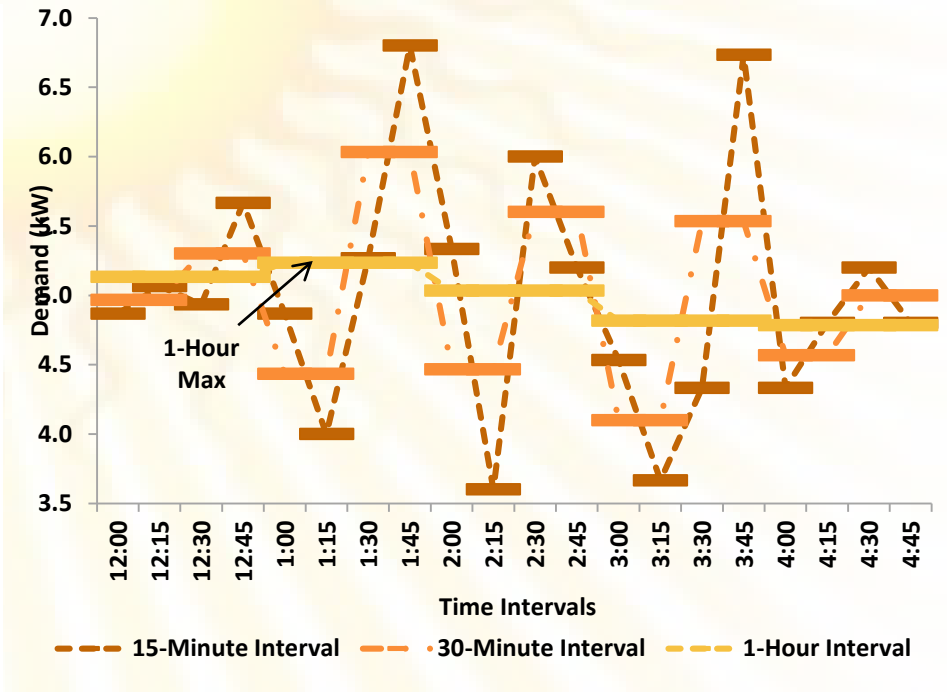
Demand charges are calculated based on the interval with the highest kilowatt (kW) usage within a billing period.

1. interval with the maximum capacity demanded is identified
2. capacity within that interval is averaged
3. average is multiplied by the utility's demand charge for that season/time to derive the demand charge component of the rate

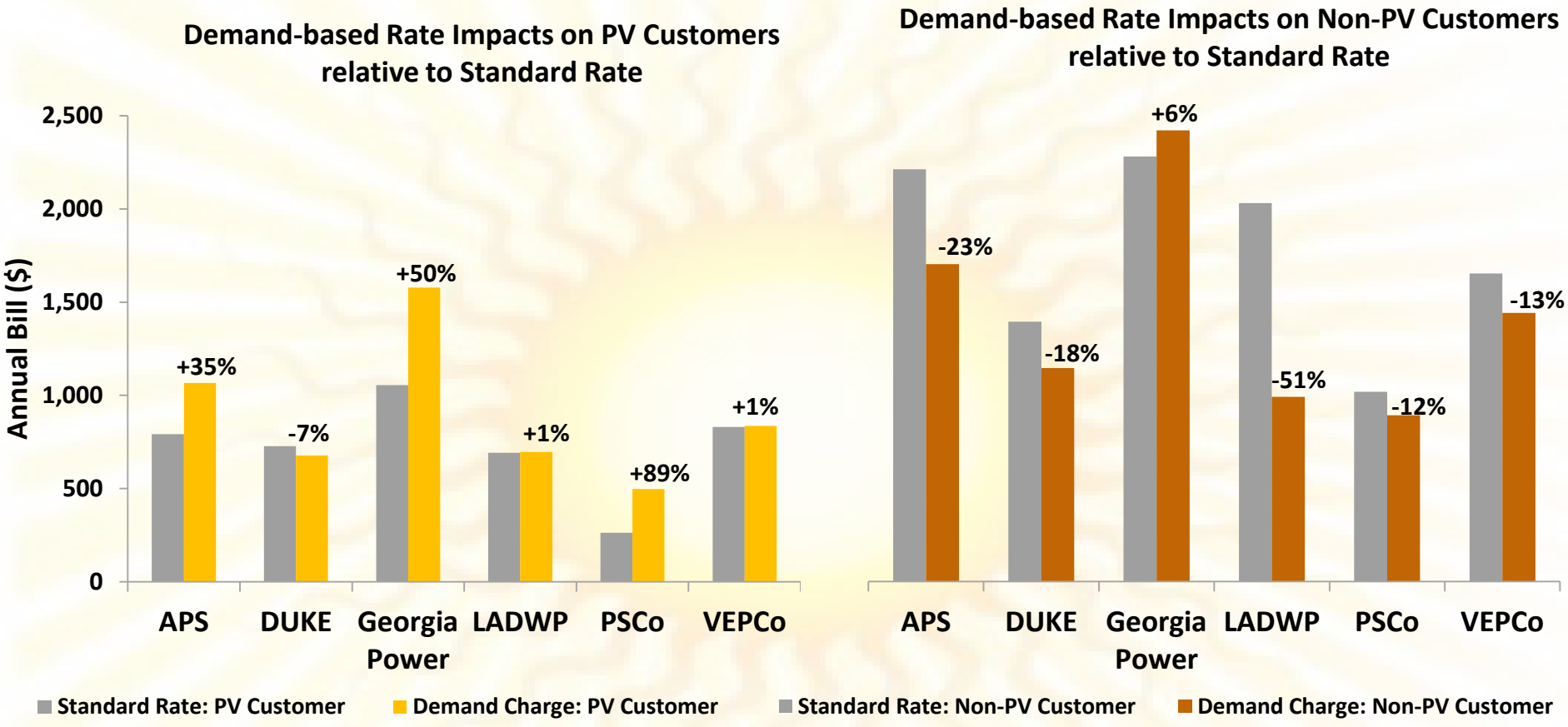
Averaging across the interval means that longer demand intervals result in lower 'peaks'.

Intent: Encourage customers to limit consumption during peak seasons and times.





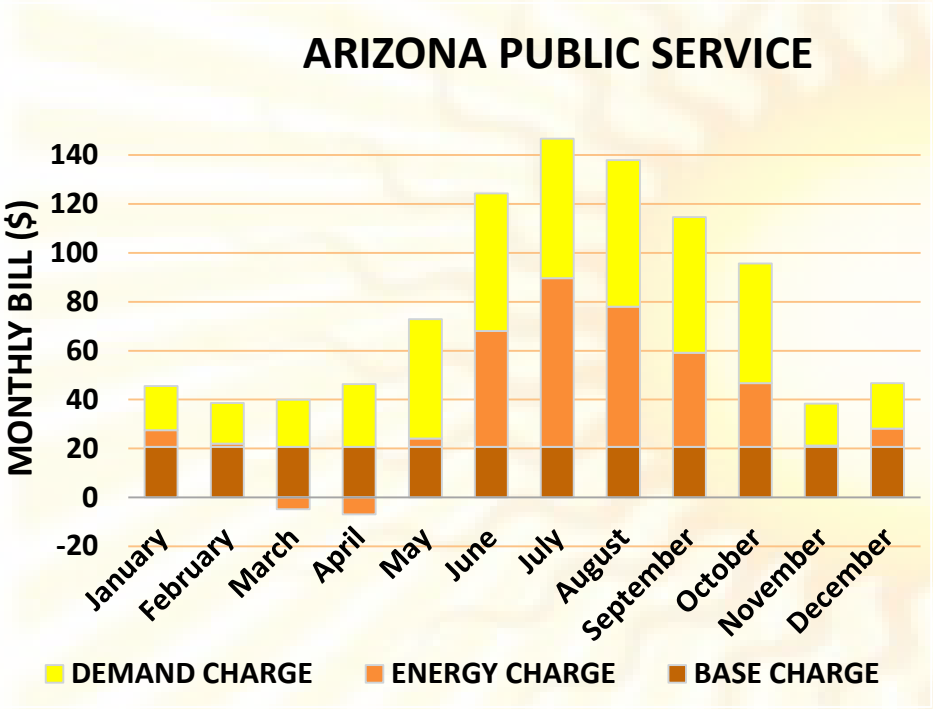
Impacts of demand-based rates



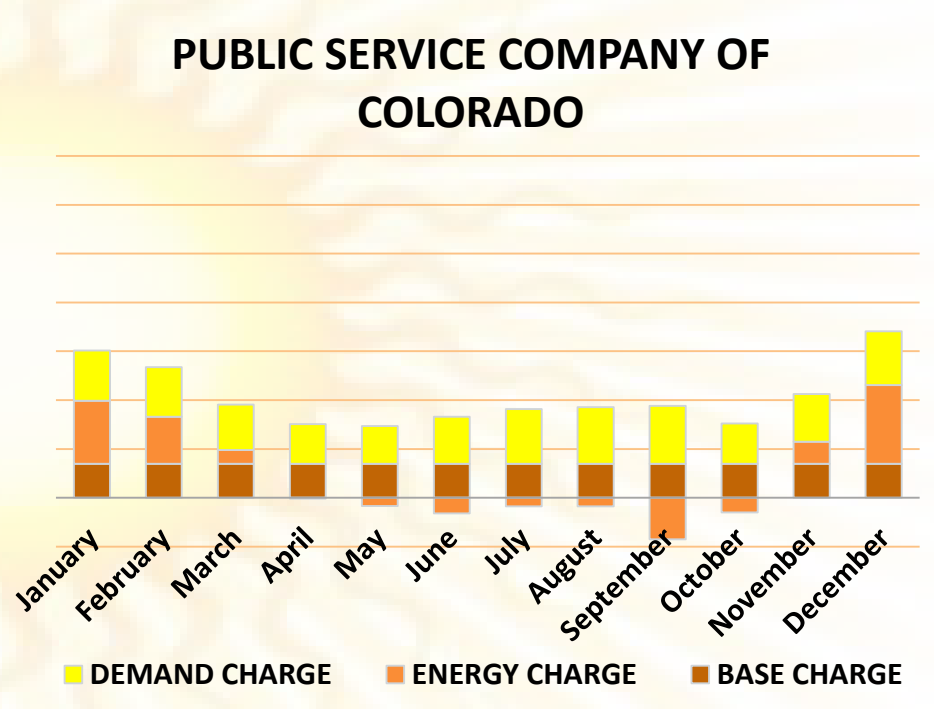
For PV customers, demand-based rates generally result in **higher** annual utility payments.

For non-PV customers, demand-based rates generally result in **lower** annual utility payments, relative to the standard rate.

Magnitude of the impact varies substantially & depends on the rate design, load profile, and coincidence of PV production with load.



- PV off-sets most/all of annual load
- Low summer demand, gas heating, good resource quality
- PV customer: 89% increase in costs
- Non-PV customer sees 23% decline in costs due to lower energy charge



- Even with 5 kW PV, energy charges still high
- High air conditioning, low resource quality
- Low demand charge; Small decline in energy charge
- PV customer: 1% increase in costs
- Non-PV customer sees 23% decline in costs due to lower energy charge

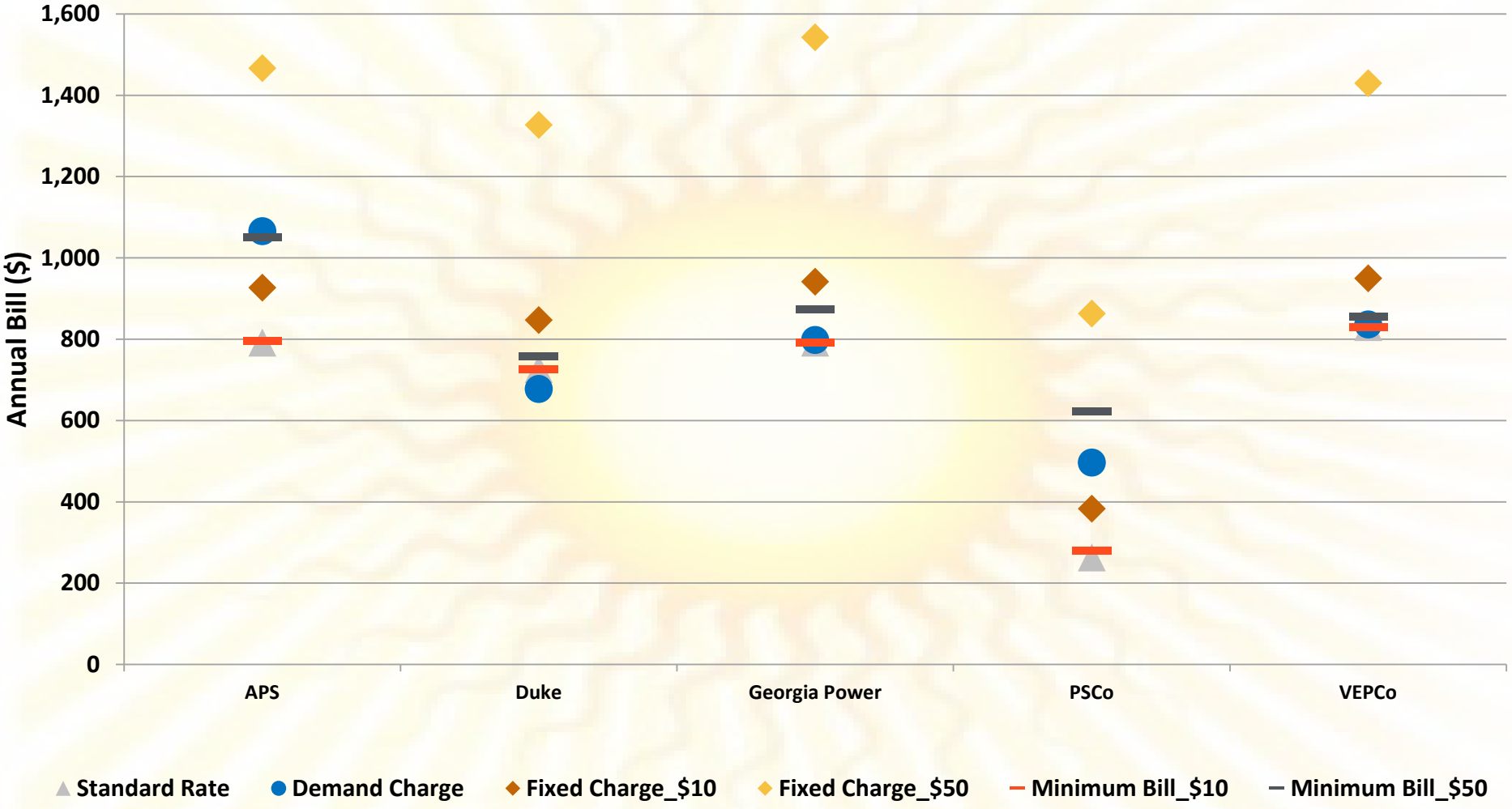
Demand Charges: Considerations

- Demand-based rates increase the amount that PV customers will pay the utility over the course of a year, and decrease bills for non-PV customers.
- If the intent is to ensure that utilities are able to recover costs from PV customers, then this analysis indicates that they do impact customer bills in a direction consistent with their intent.
- Magnitude of impact depends on: rate design (energy charge : demand charge, load profile, resource quality, and coincidence of PV production with load)
- What is the goal of a demand-based rate? Revenue recovery? Customer change? Do customers understand the rate? Can they respond to the rate signals?

Summary of Rate Alternatives Analysis

- Fixed charges are an easy blanket approach, but always increase customer costs. May discourage efficiency. May not account for system size, off-set.
- Minimum bills are easy to understand, and are only triggered when consumption is low.
- Demand charges have variable impacts, but generally increase PV customer costs while decreasing non-PV customer costs. They may be difficult to understand and respond to.

Comparison of Rate Structures on Residential PV Customer Bill



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